Vol. VII, No. 10
25 Cents a Copy

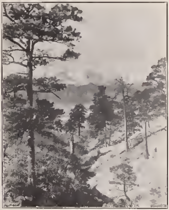
January, 1927

U. S. Postage
2c. Paid
Los Angeles, Calif.
Permit No. 941

American Cinematographer

Published in
Hollywood, California

By American Society
of Cinematographers



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THIS MONTH:

A Cinematographic Forecast for 1927—By Daniel B. Clark, A.S.C.; New 16 mm. Film Library Founded—By Hamilton Riddel; A Professional's Notes for Amateurs [Part Three]—By Joseph A. Dubray, A.S.C.

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Vol. VII JANUARY, 1927 No. 10

American Cinematographer

Foster Goss, *Editor and General Manager*

Contents:

✤

Page

Projection—*Conducted by Earl J. Denison* 4

The Editor's Lens 5

Amateur Cinematography—

New 16 mm. Film Library Opened—
By Hamilton Riddel 6

A Professional's Notes for Amateurs *(Part III)*—
By Joseph A. Dubray, A.S.C. 7

Duplication of Motion Picture Negatives *(Concluded)*—
By J. G. Capstaff and M. W. Seymour 9

A Cinematographic Forecast for 1927—
By Daniel B. Clark, A.S.C. 10

In Camerafornia—and News Notes of the Month . . 11

A.S.C. Member in Many Travels—*By Ben Allah* . . 12

Classified Advertising 24

A.S.C. Roster

An educational and instructive publication, espousing progress and art in motion picture photography
Subscription: United States, $3.00 a year, Canada, $3.50 a year, foreign, $4.00 a year; single copies 25c.
Published monthly by THE AMERICAN SOCIETY OF CINEMATOGRAPHERS, *Inc.*
Advertising rates on application.
1219-20-21-22 Guaranty Building, Hollywood, Calif. Telephone GRanite 4274

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PROJECTION • *Conducted by* EARL J. DENISON

Economy Seen *in* Good Equipment

By Daniel B. Clark, A.S.C.

Dilapidated Outfits Prove Burden *to* All Concerned, Including Audiences

Being connected with the Tom Mix company at the Fox Studios takes the writer to every section of the West for location scenes in the productions which we make. Most of these location trips send us to sparsely settled sections. If we are not camping out or roughing it, we find our headquarters in some small Western town where the chief attraction probably is a motion picture theatre. (We have learned that we never get so far in the backwoods as to be out of the territory of a film house.)

Inspects Equipment

Because I am interested in the subject of projection, I invariably take the first opportunity to make friends with the projectionists at such houses. I find that we have much in common, the projectionist being just as interested in my line of work as I am in his. It is always a matter of interest for me to observe his equipment in the projection room, just as he usually likes to look over our camera paraphernalia.

Neglected

Now to get to the point of this article:

In many of these houses, I have found up-to-date equipment. In others, I am sorry to say, I have found projection facilities sadly neglected. Very often, in the more modest establishments, the owner or manager presides over his own projectors—and has done so for many years past. It goes without saying that he is not an expert on the maintenance of his equipment, no matter how simple or foolproof it may be. He gets a passable picture on the screen, and that is all.

In still other instances, the same type of equipment prevails in houses where there are projectionists. The possibilities are that the projectors, new or second-hand, started out in the custody of the exhibitor, who, on becoming more prosperous, turned his projection room over to a projectionist. The latter, no doubt, inherited a run-down lot of instruments. It required and continues to require all his ingenuity to keep them anywhere near their original and just stage of efficiency. He no doubt is obliged to put in much of his time—and that of his employer—in keeping his apparatus in running order.

Not Possible

Now I don't think that such conditions are fair to the projectionist. Nor are they fair to the audiences. Nor are tbey fair to the exhibitor himself. If you were running a taxi system, you wouldn't expect to get by with an antiquated fleet of cars. It stands to reason that no matter how conscientious the projectionist may be with the equipment, which has suffered from ill treatment in the past, he cannot screen as good an exhibition as he would be able to if he had modern and up-to-date equipment.

No Economy

I can't see where the exhibitor can cling to the idea of economy in maintaining a worn-out system of projection. Repairs, working time, and faulty screenings more than offset any possible savings. Out of respect to every one concerned, it is my belief that in many of such houses, the best thing to do is to install a completely new array of projection apparatus. The investment involved—and it is an investment—would be more than rewarded in the elimination of repair bills, better screening, etc. Then don't let us lose sight of the effect that such equipment will have on the projectionist. I don't hesitate to say that up-to-date equipment proves a tonic to his morale. I feel that, in this respect, he is like the cinematographer, who, I am sure, enjoys the urge of having a highly efficient and modern camera outfit to serve him and, in turn, to have cared for—and not a ramshackle bunch of moving parts that might function, and might not.

The EDITOR'S LENS • • focused by FOSTER GOSS

Why Not *a* Cinematographer?

¶ Reports are appearing that Josef von Sternberg, whose reputation for "genius" persists despite two shelved pictures out of three recent directorial attempts, has been engaged to be director of photographic effects on a Paramount production of a Ben Hecht story.

¶ While as yet we do not know who is to be the cinematographer on the picture in question, we venture to believe that Paramount executives would not have had to go outside their own ranks to find some one whose abilities fitted him to be a "director of photographic effects."

¶ It is our belief that this would have been a splendid opportunity to rely on the imagination plus the scientific efficiency of some cinematographer. We believe that such an assignment would be a fitting reward to some deserving and competent cinematographer.

¶ If, when and after Mr. von Sternberg serves in the capacity mentioned, we would be interested to know just how much was contributed by the cinematographer selected toward any photographic effects appearing in the picture.

Panchromatic Predictions

¶ As predicted by Daniel B. Clark, president of the American Society of Cinematographers, in an article re-printed in another part of this issue, watch panchromatic during the coming year. This form of stock, which is steadily swinging into general usage, is something for the cinematographer to conjure with.

¶ Accepted methods of lighting and the like—with the widespread employment of panchromatic—will undergo changes. In fact, with this end in view, innumerable researches have already been conducted, the results of which will be forthcoming shortly.

¶ Another factor in the favor of a more universal adoption of this type of stock is the recent reduction in its cost. Producers who hesitated to try it heretofore on a wholesale scale now have economic barriers removed, and are coming to the point of shooting entire productions, going into lengthy footage, with it.

A Welcome Improvement

¶ A refreshing departure from exhibitor journal's methods is seen in the *Exhibitors Herald* in the matter of the reproduction of still photographs showing "behind the scene" shots in studios.

¶ In the past, it has been the custom to designate, in the captions, every one except the cinematographer who is passed over as some sort of nameless mannikin. We are told that the *Exhibitors Herald* is insisting on the cinematographer's name's being included in captions on all stills submitted to that publication's offices. Congratulations are in order for the editorial forces of the *Herald*, including Ray Murray and Harry Nichols, of the Hollywood offices of the paper. May the other trade journals follow their example.

Glass Stages

¶ If one would note the evolution of film production practice, let him check the fate of the vast glass-covered stages in the various studios. These were planned to allow production on days when the elements would have made it impossible to work—the glass keeping the disagreeable weather out but allowing enough light to enter for filming purposes. Many of these stages, if they stand at all, have had their glass painted over, thus cutting out the source of natural lighting. All of which comprises one of the changes that artificial illumination has wrought.

Mr. Carr's Opinion

¶ Writing in his own column in the *Los Angeles Times*, Harry Carr, journalist, critic, motion picture expert, scenarist, contributor to fan magazines, and philosopher, states:

¶ *"But there are not a dozen really fine cameramen in the entire industry. Nine-tenths of them are mere crank-turners. Those who really and truly understand the properties of electric lights and understand artistic composition are mostly not."*

¶ Of course we would like to know who Mr. Carr thinks the dozen are. Then we would also like to know Mr. Carr's basis of judging cinematographers That would make interesting reading, even in Mr. Carr's "The Lancer" column.

More *on* Make-up

¶ Appropos of our remarks last month on make-up, let us not forget the plight of the cinematographer who is filming a star who, in the course of a picture, changes make-up as often as it occurs to his or her fancy.

Amateur Cinematography

New 16 mm. Film Library Opened

By Hamilton Riddel

William Horsley, Pioneer *in* Motion Pictures, Sponsors Idea *for* B & H Release

THERE has, since the inception of the 16 mm. amateur motion picture outfits a little over three years ago, been a demand by owners of these outfits for professionally produced films, such as are shown in the motion picture theatres of the country. To meet this demand, the Kodascope Libraries were formed, and made immediately available to all owners of the amateur outfits, a very complete list of films. This service was rendered on a rental basis only and many amateurs availed themselves of it. The Kodascope Libraries were, and still are, a most welcome adjunct to the amateur for the full enjoyment of his 16 mm. projector.

Own Library

However, many owners cannot afford, nor are they inclined, to avail themselves of this rental service which, while very reasonable, considering the high value of the films rented, is an item of expense that is only compensated by a day's use of the film subject rented. In many cases the amateur wished to have permanently several professional subjects. Only recently were the Kodascope Library releases made available for outright purchase by the amateur who wished to have on hand, in his home, a film or two to present to his friends when an impromptu performance was to be given. Still, however, the purchase of a professional 400-foot Kodascope reel involved an expense of approximately $50. And naturally, it was not feasible to divide a reel so that the purchase price might be made lower, as the library subjects, almost without exception, were only complete when in the 400-foot lengths. The problem of supplying those amateurs who wished to purchase outright small reels of professional subjects, and those who wished to have the same, supplementing the Kodacope Library releases, still remained unsolved.

Only recently has this situation been worked out, with the result that increased and sustained interest of the amateur cinematographer will be acquired With the acquisition of this interest, photographic history will repeat itself and many innovations will materialize, for the present-day high standard of professional photography can be traced to the interest of the amateur of past years.

New Plan

It was with this paramount idea before him that William Horsley, a pioneer himself in the motion picture industry, and who owns a professional film laboratory in Hollywood, has innovated and made possible the purchase of professional subjects on 16 mm. film and in short lengths; and, which is an important item to the average amateur cinematographer, the price of these short length reels is very nominal, being only fifty cents to one dollar more than the 100-foot reel of Cine-Kodak negative film used in the 16 mm. motion picture cameras. These subjects are in 100-foot lengths, and are reductions made from the standard 35 mm. professional films.

Equipment

Recently the writer had the pleasure of being shown the 16 mm. department which Mr. Horsley has established in his laboratory. At present there are four private projection rooms; three for the "rushes"—films just finished and which are run for inspection purposes—and the other where the completed, edited films are shown. The projection rooms for the "rushes" are equipped with Bell & Howell Filmo projection machines, while the other room contains a Model A Eastman Kodascope projector with the large lamp equipment.

A Series Depue and Vance optical reducing machine is employed for making the 16 mm. reductions. The machine resembles, and incorporates the principles of, a motion picture projector. It is entirely driven by motor. On one side of the reducing machine is a lamphouse and in front of it is a film gate, through which the standard size negative is fed from the supply reel. As the negative passes the aperture, the image is projected through a lens which is so ground as to reduce the image

(Continued on Page 23)

A Professional's Notes *for* Amateurs

Part III

By *Jos. A. Dubray, A.S.C.*

Formulae, Figures *and* Facts Recorded *in* Third Installment *of* Technical Series

(Continued from Last Month)

IT is evident that the reflecting surface of a mirror can be other than a plane surface, as we have heretofore assumed.

A curved mirror may be *spherical-concave; spherical-convex; conical; parabolical,* etc., according to the form of its curvature.

The surface of a spherical-concave mirror is that of the interior face of a one-Case segment of a hollow sphere, silvered, smooth and polished, turned toward the incident light; while a spherical-convex mirror presents to the incident light the bulging surface of a sphere.

In the same manner, a conical mirror is a reflecting surface shaped as a cone, and a parabolic mirror whose surface is generated by the revolution of the arc of a parabola.

We shall not dwell on the reflecting properties and image formation of curved mirrors, because of their extremely limited use in photographic instruments.

We will limit ourselves to note that *spherical mirrors* do not form sharp images due to a phenomena called *spherical abberration by reflection,* if their aperture is subtended in an angle exceeding 8 to 10 degrees, and the *parabolic mirrors,* which are free from this defect, are extremely difficult to construct with the precision wanted in all optical instruments.

* * * *

IN the brief outline on Reflected Light, dealt with in the preceding chapter, we did not have to concern ourselves with the *medium* in which light was travelling. Both, the Incident and the Reflected Ray, were assumed to travel in the medium *air.*

Let us consider, now, a ray of light, which is emanated by a luminous body in a certain medium, and strikes the surface of another medium of different nature than the first. Let this second medium be a transparent one, and let the ray of light be *monochromatic,* or of *one color* only.

When Light is incident at the surface of separation of such two media, one portion of it is *reflected back* in the first medium; part of it is *absorbed* by the second medium, and the remaining portion, is *refracted,* and transmitted through it.

We have already stated that light travels following a straight path, independent of the nature of the medium, but its velocity varies according to the molecular composition of the medium, and the wave-length of the light.

While considering *monochromatic light,* we shall concern ourselves, only with the nature of the *medium.*

In the *atomic* and *molecular theory,* an *atom,* is considered to be the smallest quantity of *matter,* that takes part in chemical reactions.

We all know that water is a compound of two elements, *hydrogen and oxygen.* Following chemical nomenclature, water is expressed by the formula H_2O which means that *two* parts of hydrogen compounded with *one* part of oxygen, form *water.*

It is obvious, that there must be a *minimum* quantity of oxygen, which is capable of compounding with two *minimum* quantities of hydrogen, in order to form *one minimum* quantity of water.

These minimum quantities of elements, which are so small that they are invisible even through a microscope, and are indivisible by chemical reaction, are called *atoms,* while the minimum quantity of the compounded is called a *molecula.*

Briefly, *one atom* of oxygen, compounding with *two atoms* of hydrogen, form *one molecula* of water.

Atoms and moleculae are separated from each other, but possess the power of attracting each other, thus holding onto each other, and the extent of this power, determines the *density* of the body.

The separation between atoms and moleculae permits consideration of the existence of the luminouferous *ether, within* all bodies.

Recent investigations have greatly developed the atomic and molecular theories, and the atom itself is considered to be an aggregation of extremely small electrically charged particles, called *"electrons."*

Electrons, or charges of negative electricity, are supposed to be in constant, rapid, orbital motion, somewhat similar to the motion of the planets around the Sun, the sun of the electrons being, perhaps, a particle charged with positive electricity.

The number of electrons, in an atom, is supposed to determine its nature.

Prof. Millikan, precognize the existence of still smaller particles, or *sub-electrons.*

Electrons and sub-electrons are considered as forming the connecting link between *ether* and *matter*, and as determining by their arrangement and their motion, all optical phenomena that divert from the *ether* itself.

IT is evident, that when light passes from the *free ether*, into the *ether* pervading inter-atomic spaces, a retardation or slowing of its speed will happen

This retardation, is caused by the behavior of the light-waves.

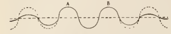

FIGURE 5. Light waves in vacuo and in a denser medium.

The speed required to carry a wave-crest from A to B, (Fig. 5), is termed the wave-speed

The dotted line shows the behavior of light-waves in *free ether* or *vacuo*, but when light passes through a medium, its front waves continually die away as shown by the full line in the figure, and are constantly replaced by the following waves, each of which proceeds further than the preceding one, while new waves are constantly forthcoming, from the luminous body.

This dying away and replacement of waves, results into a retardation of their velocity.

The group of waves, illustrated in the figure, moves then at a lesser speed than the speed of the individual waves and this speed is lesser, the denser the medium is.

The change of speed is cause of a *change of direction* of the light ray, which change of direction takes place *at the surface of the second medium*, and is termed "*refraction.*"

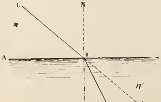

FIGURE 6. Single refraction of Light.

Let n and n' be the two media, and let n' be transparent and denser than n.

Let A B, be the surface of the Medium n' and NN' the Normal to A B at the point O.

Let L O be an incident ray of monochromatic light, impinging upon the surface A B at O.

It is observed that the ray, instead of following a straight line in the direction L L', is bent at O, or *refracted* in the direction O R.

The angle L O N, which the Incident ray makes with the Normal, is called the "*angle of incidence.*"

The angle R O N', which the ray makes with the Normal, is called "*angle of refraction.*"

The angle R O L', which the ray makes with the imaginary prolongation of the incident ray within the medium, is called the "*angle of deviation.*"

IT is the phenomena of refraction that make a stick appear bent when partially immersed in water. It is also through refraction that a much-heralded experiment can be made.

Place a coin in an empty basin, and place your eye in such a position that the brim of the basin barely masks the coin from your sight. Slowly pour water into the basin, without changing the position of the eye and soon you will be able to perceive the coin. The coin, acts as a luminous body, and it is the bending or refraction of the rays emitted by it, when passing from the Medium Water into the Medium Air, that seem to change the position of the coin itself.

It should be borne in mind, that in this experiment, the rays pass from a denser medium (water) into a rarer one (air).

This brings to our mind the Law of reversibility of Light. In Fig. 5 if the luminous point was situated at R (i.e. in the denser Medium), the refracted ray would follow the path O L in the rarer medium, and the Angle of Refraction, would then be greater than the Angle of Incidence.

Experimentation has proven that the phenomena of *refraction* always occur when light travelling in one medium is incident upon the surface of another medium of dif-

(Continued on Page 19)

Duplication *of* Motion Picture Negatives

Continuous Form *of* Machine Found Best *to* Develop Master Positive *and* Dupe Negative.

*By J. G. Capstaff and M. W. Seymour**

Contrast Control Property May Be Used *to* Advantage *to* Get Highest Grade Work.

(Continued from Last Month)

If the master positive and duplicate negative are to be printed by contact, great care must be taken to insure close and uniform contact of the films at the printing aperture; otherwise the advantages of the high resolution emulsion will be lost. It is obvious enough that poor definition will result if the films are out of contact during printing, but it is not so obvious that lack of uniformity in contact can do any particular harm. If the two films are not in close contact over the whole picture area, a patchy image is produced which, on projection, resembles uneven development. To test a printer for uniformity of contrast, a print should be made from a strip of evenly fogged and developed negative film. If the printer is in perfect adjustment, the print will show an even tint, while imperfect adjustment will give the patchiness referred to. The best type of printer has a curved track and pressure plate. The radius of curvature should be small, about 1½ inches, and the pressure plate should be undercut over the picture area so that it presses only on the sides of the film over the perforations.

Unit Magnification

When projection printing is resorted to for printing either the master positive or the duplicate negative, the lens chosen should be one designed to work at unit magnification. Ordinary camera lenses do not give their best definition under these conditions, because they are designed to focus sharply objects at a distance. Clearly, the focusing of the printer lens must be very critical if the sharpness of the original negative is to be attained. It is important to keep the lens clean, since the slightest mark or film of dirt on the lens will scatter the light rays and distort the tone reproduction.

For developing both the master positive and the duplicate negative a good form of continuous machine is best. Next to this comes development on a reel. The spacing of the supports on the reel should be close, so that the film will lie in a smooth spiral. Wide spacing of the supports gives uneven development.

If tank development must be used, the rack should be lifted completely out of the developer once every minute so as to prevent rack marks

Developer

The developer recommended is:

	Metric	*Avoir*
Elon	4 grams	1 lb 10 oz
Hydroquinone	1	6½ oz
Sodium Sulphite	75 "	31 lbs
Sodium carbonate	25 "	11 lbs
Potassium bromide	1.5 "	10½ oz
Water to	1 liter	50 gals

With unused fresh developer at a temperature of 68° to 70° F., the effective maximum of contrast ought to be attained in about four minutes. Development beyond that required to give maximum contrast must not be given or increased graininess will result.

The master positive development, if correct, will give a print somewhat softer than one intended for projection. It will also, of course, differ from the latter in having a slight veiling over the highlights.

Sufficient Washing

The usual acid hardener fixing bath may be used for fixing, although the hardener tends to set the dye and retard its washing out of the film. Sufficient washing should be given to clear the film, since a very little yellow dye will cut down the printing light and make timing more difficult.

If it is desired to make a duplicate negative that can be printed without light changes, the timing of the master positive must, of course, be accurate. By projecting the master positive, one can readily determine which scenes need more or less printing light than the average, and with a little experience the light change required can be estimated quite closely. The "key" light can be ascertained in the usual way by printing and developing a test tsrip. The scene chosen for the test should be of the most contrasty subject; that is, the scene with the darkest shadows, and the printing exposure should be just sufficient to give a veiling over the deepest shadows. If this precaution be taken, all of the other scenes will automatically be taken care of, and the tone reproduction of the entire length will be satisfactory.

(Continued on Page 20)

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*Research Laboratory of the Eastman Kodak Company this paper was read before the recent meeting of the Society of Motion Picture Engineers

A Cinematographic Forecast *for* 1927

By Daniel B. Clark, A.S.C.

Anticipates *that* Coming Year Will Be Crammed *with* Motion Picture Advancement

(The following story, written by Daniel B. Clark, president of the American Society of Cinematographers, appeared in a recent issue of the HOLLYWOOD MAGAZINE, by special permission of which it is reprinted here:)

With great and general progress having been attained in the field of motion photography during the twelve months just closed, 1927 promises to be a year unprecedented in the advancement of cinematography.

Great strides undertaken in the calling of the cinematographer during 1926 will come to fruition within the next several months with the result that this branch of the cinema profession bids fair to be nothing short of revolutionized before the new year becomes gray and hoary.

Inasmuch as cinematography always sets the pace for the film business in general, we may safely assume that the coming seasons will be epochal in the annals of the photoplay.

Last year saw the advent of faster lenses; 1927, it is predicted, will see even more speedy lenses put on the market. The cinematographer alone realizes just what this means to the finished film production. Photography under light conditions which heretofore would have defied "exposures" has now become possible. These possibilities, in turn, will be even more widened within the next several months, if developments, now in the course of perfection, arrive at successful consummation.

Probably the greatest improvements in cinematography will come through the widespread and general use of panchromatic film, now considered the great element of magic by all those who are real students of the motion picture industry. Before the past year, panchromatic was something of a novelty, rarely if ever used. By the time 1926 had spent itself, however, it had come to pass that several important productions had been filmed not partially, but entirely on panchromatic stock. Alfred Gilks, a member of the American Society of Cinematographers, employed panchromatic exclusively in the filming of Paramount's "Old Ironsides," a James Cruze production, on which Gilks was chief cinematographer. His cinematographic results are now winning the resounding praises of the film critics in New York City, where the feature recently was given its world-premiere. George Barnes, another member of the American Society of Cinematographers, likewise photographed "The Winning of Barbara Worth" in its entirety on panchromatic negative.

The ramifications of this new form of film stock are truly revolutionary in their scope. When it is considered that in "Old Ironsides," this type of film made it possible for the entire cast to go through the story without the use of make-up, which has become nothing short of a permanent institution in the studios, the foregoing statement is in some measure realized.

The most signal deviation in picture production methods which a wholesale application of panchromatic will bring about will be in the matter of illumination. Methods which have stood the test of time and accepted usage now show signs of tottering, and just how far this collapse will go only the next several months will reveal. The reason for all this is the different kind of sensitivity in panchromatic. It differs in this respect from "par" stock in that light values, visible to the eye, have a different effect in this new creation of the raw stock laboratories. One the other hand, certain portions of the spectrum, amounting to light not visible to the eye, are very forcibly recorded on panchromatic. All of this simmers down to this circumstance: a cinematographer may have more than enough light thrown on an actor when he is apprehensive that he does not have sufficient illumination.

This change of facts will result in the readaption of the various light sources, with incandescent lighting coming into increasing vogue. The American Society of Cinematographers has anticipated all of these changes, and, early in 1926, laid definite plans to reduce affairs to a practical working basis when the time of transition and then ultimately of change did arrive. The total of the research

(Continued on Page 21)

In Camerafornia...

and News Notes of the Month

METRO-Goldwyn-Mayer has been active in availing itself of and continuing the services of A.S.C. members.

John F. Seitz, A.S.C., for the past several years chief cinematographer on Rex Ingram productions, has been signed by the Culver City organization. Seitz has photographed all of Ingram's most successful efforts, including "The Four Horsemen of the Apocalypse." His first picture under his new contract was to have been "Wind," starring Lillian Gish and directed by Clarence Brown, but this schedule was recently changed. Seitz spent two years in Europe filming the Ingram pictures made across the Atlantic, and returned to Hollywood during the past autumn.

John Arnold, A.S.C., has been signed again by Metro-Goldwyn-Mayer. Arnold was chief cinematographer on "The Big Parade." Prior to joining M-G-M, the A.S.C. member, like John Seitz, was for many years identified with the old Metro studios, where he photographed Viola Dana's starring vehicles during a record run of service. Arnold's first picture under his re-newed agreement is "Mr. Wu," starring Lon Chaney and directed by Will Nigh.

Ira Morgan, A.S.C., also has signed a new contract with Metro-Goldwyn-Mayer. He recently finished shooting "Tell It to the Marines," which is now being given its premiere in New York City. Morgan has photographed the outstanding Marion Davies features of the past several years.

* * *

Robert Kurrle, A.S.C., has gone to Truckee for snow scenes in Edwin Carewe's production of "Resurrection," starring Rod La Rocque and Dolores del Rio. Frank B. Good, A.S.C., accompanied Kurrle to the mountain location to aid in the filming of the snow sequences.

* * *

John Stumar, A.S.C., has begun the photographing of "The Claw," a Universal production which is being directed by Sidney Olcott. Norman Kerry and Claire Windsor are featured.

CARL E. Akeley, sculptor, inventor and photographic explorer, died, Nov. 17th in the Kivu district of the Belgian Congo, Africa.

Akeley, who was famous for his motion pictures taken in the jungles and other uncivilized regions, was particularly known in motion picture production quarters as the inventor of the camera which, bearing his name, is widely used in film making.

* * *

Gilbert Warrenton, A.S.C., has rung down the curtain on the cinematographic mysteries of "The Cat and the Canary," in which Universal is starring Laura La Plante with a record cast. Warrenton has started to work on another Universal feature, "Beware of Widows," starring Miss La Plante and directed by Wesley Ruggles.

* * *

Fred W. Jackman and Floyd Jackman, both A.S.C. members, spent the Christmas holidays in the wilds of a Nevada location where Fred is producing, for Hal Roach and Pathe release, the latest production starring "Rex," the "king of wild horses." Floyd is chief cinematographer.

* * *

HERFORD Tynes Cowling, A.S.C., has just experienced a banner month. Besides joining the cinematographic forces of the Eastman Kodak Company in Rochester, N. Y., he was elected a fellow of the Royal Photographic Society of Great Britain. This is an honorary degree bestowed only for exceptional researches and accomplishments in photography.

* * *

Ned Van Buren, A.S.C., likewise affiliated with Eastman's motion picture activities, has returned to the kodak city from a trip to the Panama Canal zone where he filmed subjects designed for educational use.

* * *

Arthur Edeson, A.S.C., will photograph Richard Barthelmess' first vehicle as a First National star. The feature is "The Patent Leather Kid." Alfred Santell is directing, with Al Rockett as the supervising producer.

HERBERT Sylvester, of Creco, Inc., has had several lighting tests made during the past few months to ascertain the light flux values of the 10 K.W. and 5 K.W., 10,000 and 5,000 watts respectively, nitrogen gas filled incandescent lamps, co-operating with Peter Mole, of Creco; F. E. James of the General Electric Company and Arthur Shadur, Universal executive and members of his technical staff.

These tests were conducted on the several grades of Eastman, Agfa, Goerz and Dupont film stock, as advocated on the present film market.

Mole has had previous experience in this connection, having been a member of the General Electric Research staff, at Schenectady, New York, during the Maud Adams experiments with incandescent lamps as a photographic lighting medium.

* * *

Joseph A. Dubray, A.S.C., has finished shooting "Husband Hunters," a Tiffany production directed by Jack Adolifi. Stephen S. Norton, A.S.C., was associated with Dubray in the the filming. The cast included Mae Busch, Walter Hiers, Jean Arthur, Charles Delaney, James Harrison, Duane Thompson, Robert Cain, Mildred Harris and Otto Lederer.

* * *

Charles J. Van Enger, A.S.C., has completed the photographing of "The Runaway Enchantress," a First National production, starring Milton Sills and directed by John Francis Dillon. The cast included Alice White, Arthur Stone and Mary Astor.

* * *

Charles Stumar, A.S.C., has returned from a location trip down South where he journeyed for the filming of Universal's production of "Uncle Tom's Cabin," which is being directed by Harry Pollard.

* * *

Gaetano Gaudio, A.S.C., has finished the filming of First National's "Three in Love," directed by Millard Webb and featuring Lewis Stone, Billie Dove and Lloyd Hughes.

A.S.C. Member In Many Travels

By Ben Allah

Herford Tynes Cowling Covers Thousands of Miles in Every Part of Globe's Surfaces

IF there is a title of "most traveled American," it has probably changed hands in the last two years because of the determination of a gentleman from Virginia. Herford Tynes Cowling, moving picture photographer and traveler extraordinary, has slept beneath the flags of all nations and has reached spots in his wanderings where few white men have been before.

Though but thirty-six years old, he has accomplished much, traveled more than a million miles and has seen the strangest things on earth. To Cowling the earth has no far corners. He has rounded them out, gone over the hill and found what the other side had to offer. He voices but one regret, that he has to part with the many friends he has made in so many lands.

Three Years

In his last trip which took him around the world and lasted three years, he succeeded in entering the forbidden country of Tibet. But few white men have actually gone into this land of religious mystery and dizzy heights. Cowling has even successfully reached the inner sanctuaries of the Lamas in their strange Tibetan monasteries who call their portals "forbidden," and are deserving of the name.

Rumored City

Many rumors reached this world-traveling cinematographer of a city that was inaccessible to anyone except natives. He hung around the court of the Maharaja of Kashmir until he could gain his favor and assistance to cross the forbidden border. Then with trusted servants and food supplies to last months he headed across the Himalayes for Leh, the capital of Western Tibet. Then came the long overland trip. He was warned that white men who had tried the feat from time to time were never seen again. He came to the city of Leh after a trip which rivals Arabian yarns of old and entered, cameras and all, made friends with the Skushok, their reincarnated "man God" leader, and came out with the first pictures of the Lama devil dances and ceremonies.

No Barriers Recognized

The determination which made a world traveler of him made him a successful one in that he goes where he wants to go to make pictures and stops but for one reason: that there is no possible means of continuing.

For seven years he was chief photographer of the U. S. Interior Department and won an enviable record in this position. It was in his travels in the United States, Mexico and Canada that he first decided that he would see the world. Not half of it, nor most of it, but *all* of it.

Starting out in 1917 he headed successively expeditions into the South Sea Islands, Australia, New Zealand, Tasmania, the Philippines, Indo China, Siam, China, Japan, Formosa, Dutch East Indies where educational pictures of a heretofore unknown nature were made. It was on these trips he made a name for himself in the world of travelers and as an explorer. Natives who showed him their ways of living respected him as a white man they could understand and one who understood them.

Character at a Glance

With the natural trait of being able to read character, he seems to see through the superficial coverings of flesh and read native souls beneath. He knows the right time to approach anyone of the numerous tribes of the far-flung points. He studies their customs and lives them, in so far as it is possible for a white man to do, when he is among them. He has been taken into many tribes as an adopted member and likes all the strange brown and black men, yellow men and olive hued ones who boast this American citizen as theirs also.

Abounds with Energy

While determination and study coupled with a natural faculty for understanding have gone far toward making the work of this young American a success, nonpariel, probably the greatest single factor contributing toward this success is the dynamic personality of the man himself. No human being ever came closer to being a dynamo in the flesh. He is active and going all the time he is awake and he is awake most of the time. He keeps busy and he keeps his men busy and whoever happens to be near just naturally falls into the pace and gets busy. Friends standing around Cowling "hit the stride" of the leader

(Continued on Page 16)

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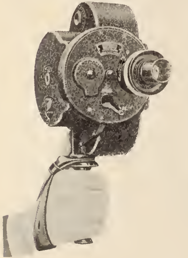

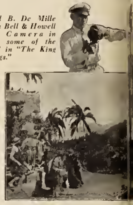

Cecil B. De Mille using a Bell & Howell Eyemo Camera in filming some of the "shots" in "The King of Kings."

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Ernest Torrence, as "Peter the Beloved" in Cecil B. De Mille's "The King of Kings."

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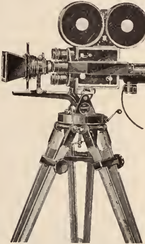

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A. S. C. MEMBER IN MANY TRAVELS

[Continued from Page 12]

and in short order find themselves busy at something. He radiates energy.

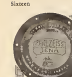
He is not the Napolenic concentrated type of machine but is more the Theodore Roosevelt model since he is just six feet tall and weighs around one hundred seventy pounds. Tropical suns, changes of food or whatever hardships he must endure seem to leave no lasting effects on the remarkable store of vitality that goes into his makeup. It is truly a remarkable constitution that can weather the July equatorial sun and then suddenly move over into the Himalaya Mountains' altitude as fast as available transportation will take care of the movement. The shock of change has apparently left no mark on him. He weathers the cold as well as he does the heat, though in a moment of confidence he made the confession that since he was born and reared in the South of the United States, he felt it would be disloyal of him not to say that the warmer lands have more appeal.

Boiled Water

Health is a big factor in successful travel and, while blessed with a robust body, there is one point on which Cowling insists while in foreign lands. All water he drinks must be boiled first. He has by this means escaped the fevers and other maladies so common to the new arrivals anywhere. One case of a lost job is on record because of the laziness of a native boy who did not boil the water the night before for the following day's drinking. The substitution of unboiled water was found out and there was one less native boy in the employ of the man who would safeguard his health by this most effective means.

In Singapore

It was the pleasure of this writer to be in Singapore on one occasion and to meet Herford Cowling. The boys about Raffels Hotel were buzzing early in the day, having news of the reservation made by Cowling saying that he would arrive on the steamer from Batavia about noon. Upon inquiring at the desk for Mr. Cowling, the information was given out that he would be in later in the day. The bell boy knew that he was returning and looked forward to it; the clerk knew it, the



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manager knew it, the room boy knew it (they use room boys instead of maids in Singapore); in fact, every one connected with the hotel seemed to be busy that day, looking forward to the arrival of this one American who on previous visits had infused the spirit of action into their usual latent working spirits.

Virginian

Thousands of foreigners visit this cosmopolitan hotel each year from many climes and lands, but it is the distinction of this one young traveling American to be the one guest whose arrival is looked forward to with pleasure. They have Sultans from nearby realms, they have dignitaries from the locale, they have all the good spending millionaires from the golden land of America and none receives the acclaim that the boy from Virginia inspires.

It chanced that the boat was late on arriving at Singapore (as boats usually are) but when the set hour passed and the looked-for guest was not yet at the hotel, the boys began to fidget, the manager became annoyed that boats should inconvenience anyone, and the smile did not return to his face until the smiling Cowling stepped from a "rickshaw" at the door. Everybody in the hotel stopped work for a few minutes to greet the picture man. Later information given out in answer to a question revealed the fact that he had been at the hotel several times before and always stopped there on his way through Singapore—"the gateway to the East."

It is apparent that he is not beloved of the natives and the hotel folk because he is classed as a rich American spender, for he is not that. Having traveled as much as he has, long since the lesson of getting his money's worth has been learned. As long as it is possible to get a big figure for anything done, the native, especially in the Orient, will try to place exorbitant prices on his wares or work. Once he finds he cannot get more than what is fair, he is much easier to deal with. Cowling is well liked in spite of the reputation he enjoys of being able to get value for his dollars. This is a distinction not to be laughed at, since most Americans who travel in the Orient and fail to scatter their money to the four winds are considered very cheap customers. It is an art to be able to get for one's dollar the value of a dollar, and still be respected.

A Rickshaw Ruse

An amusing story is told of how Cowling managed to get full value for his dollar from

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a "rickshaw" puller, than whom there is no harder to handle in this matter. The trusty Malay servant solved the problem for him. They reached a city up the peninsula where they had been many times before. The distance from the station to the hotel was just two blocks. The "rickshaw" fee for this distance is not established by law but twenty cents is the usual price; however, on reaching the hotel the coolie insisted on being paid one dollar for the full legal hour rate, saying that he worked only on the full hour rate. Argument was of no avail. The human horse had decided to steal a dollar and was sticking to his guns. About this time, the Malay servant, who had been looking after the baggage, came into view, found out what the trouble was about and told his master he would settle the account. The wily servant then climbed into the rickshaw vacated by Cowling, ordered the boy to pull him to a nearby hill and to go up an down that hill until the hour was up. On the third trip the coolie decided to take the "usual" fee given him for short pulls and not climb that hill again. Cowling admits it was the ingenuity of his servant which saved him from being the usual tourist sucker on this occasion.

Acclimation

While this life of travel and adventure is a fascinating one, it is also one of great danger as evidenced by recent deaths of British explorers in the ascent of Mt. Everest. Though establishing no record for mountain climbing, it was the pleasure of this gentleman to scale great passes over 18,000 feet and go up the pale sides of the highest mountain range in the world. It is only the white man who is not acclimated who suffers severely in these climbs, according to Cowling, and it is well to know just where to stop.

The natives of Tibet go to great heights and can stand much physical endurance. To express it in his own words:

"While my camera and equipment were being carried up with about forty pounds of weight to the back of each native, when I reached the spot where I wanted to 'shoot,' I was gasping for breath and wasn't sure just how long I could stand to remain at this level. The natives always came up smiling, their re-

(Continued on Page 21)

(Continued from Page 8)

ferent density, and also that *"a certain relation always exists between the proportional difference of magnitude of the angles of incidence and the angle of refraction, in reference to the nature of the medium."*

This fact brings about the necessity of having recourse to angle measurements.

Trigonometry is that branch of mathematics that comes to our assistance.

WE consider opportune to divert for a while from our subject, in order to give a brief description of the three trigonometric functions, the knowledge of which is indispensable for the clear understanding of the optical phenomena we are about to describe.

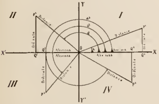

FIGURE 7.

Draw two lines perpendicular to each other at the point O (Fig. 7) and call the line X' X, the X-*axis*, and the line Y Y', the Y-*axis*.

The two intersecting axes divide thus the plane of the paper into four parts, called *quadrants*, and distinguished from each other, by the Roman figures I; II; III; and IV.

The quadrants serve to determine the position of the angle taken into consideration, according to the terminal side of the angle itself. Thus:—

The Angle X O P^1 is in the *first quadrant;* the Angle X O P^2 is in the *second quadrant;* the Angle X O P^3 is in the *third quadrant*, and the Angle X O P^4 is in the *fourth quadrant.*

Furthermore:

The *lines* O P^1; O P^2; O P^3, and O P^4 are called *distances.*

The *lines* O X' and O X are called *abscissae* and are reckoned as *positive* if extending to the *right* of O, and *negative* if extending to its *left*. Positive values are optionally preceded by the sign —|— (Plus); Negative values are *always* preceded by the sign — (Minus).

The *lines* perpendicular to the Abscissae, are called *ordinates* and are reckoned as *positive* if extending above the X-*axis*, and as *negative* if below it. The same rule of signs given for the Abscissae prevails for the Ordinates

The RATIOS for any of the angles ***a***; a^1; a^2, or a^3 are:

$\frac{\text{ORDINATE}}{\text{DISTANCE}}$ equals *SINE* ***a***; a^1; a^2, *or* a^3.

Usually written *sin* ***a***, etc.

$\frac{\text{ABSCISSA}}{\text{DISTANCE}}$ equals *COSINE* ***a***; a^1; a^2, *or* a^3. Usually written *cos* ***a***, etc.

$\frac{\text{ORDINATE}}{\text{ABSCISSA}}$ equals *TANGENT* ***a***; a^1; a^2, or ***a*** . Usually written *tan* ***a***, etc.

It is evident that these ratios will never change for each of the functions, no matter at what distance from O, the Ordinates may be drawn. It is also obvious that they give *a measureable and perfect definition of any angle*, as well as its *positive* or *negative value.*

THE relation existing between the angles of Incidence and Refraction, and the Density of the Media, has brought forth the following *law*, known as the "Snell Law," from the name of its discoverer:

1. *"Whatever the obliquity of the incident ray, the ratio which the sine of the incident angle bears to the sine of the angle of refraction, is constant for the same two media, but varies with different media.*

2. *"The incident and the refracted ray, are in the same plane, which is perpendicular to the surface separating the two media."*

(Continued on Page 24)

DUPLICATION *of* MOTION PICTURE NEGATIVES

(Continued from Page 9)

How to Gauge

In order to learn if the duplicate negative will require a longer or shorter development than that given to the master positive, superimpose one of the scenes in the master positive on the corresponding scene in the original negative. If the registered positive and negative images exactly obliterate each other, then the duplicate negative should be given the same development as the master positive received. A faint residual negative indicates that a somewhat longer development must be given to the duplicate negative; if, on the other hand, a faint positive image be seen, the negative should be developed for a shorter time than that given to the master positive.

If the various steps in the preparation of the duplicate negative are carried out correctly, it will stand the test of direct comparison with the original under a low power magnifier.

Examination under a higher power lens, however, will probably show some loss in definition and an appreciable increase in graininess. The definition loss arises, for the greater part, from poor contact in the printer. Too much emphasis cannot be laid on the necessity for intimate and uniform adjustment at the printing aperture.

Prints Kept Soft

Some increase in graininess over the original negative appears to be inevitable, but that obtainable on the Eastman Duplicating emulsion is, as has been stated, considerably less than is given by any of the regular emulsions. To keep the graininess of the final prints at a minimum, the prints should be kept as soft as is consistent with good projection quality.

Filters

In the foregoing procedure it has been assumed that any modifications required in contrast would be secured in the usual way by slightly varying the amount of development. The Eastman Duplicating Film, however, has a unique property not mentioned hitherto which can be made use of in practical work. The contrast or gamma of the image can be varied within wide limits merely by altering the color of the printing lights; in other words, a contrasty, medium, or soft master positive can be made at will with the same amount of development. A yellow filter placed between the printing light and the film will give a high contrast image, white light will give a medium contrast, while a deep violet filter will give a low contrast. By taking advantage of this fact it becomes quite practicable to print onto the same length of film from contrasty and soft negatives and to compensate for the variation in negative quality by printing through suitable filters. In practice it is found that three violet filters of different dye densities will give the range of control necessary on average commercial work.

A precaution not to be overlooked is that the printing light should always be run at a standard voltage because of the color change that occurs with voltage changes. If the brightness of the printing light is changed by a rheostat from scene to scene, the scenes printed at low voltage will tend to be of higher contrast than those printed at high voltage. This is true whether or not filters are used. It is advisable to run the lamp at constant voltage and to use the diaphragm method of changing brightness.

In conclusion, it may also be pointed out that the highest grade of work on the new emulsion is produced when advantage is taken of its contrast control property, because this permits of complete development for every scene with the consequent avoidance of all development irregularities.

Junior Cameramen's Club Elect Officers *for* Next Twelve Months

At the annual election of the Junior Cameramen's Club the following members were elected as officers:

Burnett Guffey, Goldwyn Studio, president; David Ragin, Fox Studio, vice-president; Max Cohen, Fox Studio, secretary; Hatto Tappenbeck, Fox Studio, treasurer; Ira Hoke, First National Studio, director; John Schmitz, Fox Studio, director; William Margulies, Fox Studio, director, and Clifford Shirpser, Paramount Studio, director.

(Continued from Page 18)

spiration and heart action apparently normal."

Probably the best X-ray view of the inner soul of this adventurer is to be found in his attitude as a hunter. He is fond of animals, has shot many of them for food but does not care to shoot for sport, preferring rather to film them alive. He was invited to a tiger hunt by one of India's Rajas. He had never shot a tiger and, while he wanted to film a hunt, did not want to kill an animal uselessly. He explained his feelings to the native hunters and was taken to a nearby burial ground and shown the graves of eight people who had been killed by tigers. That was enough justification. He killed a tiger that day, and hunting these felines is about as dangerous as hunting any big game.

On the entire trip through Africa where he accompanied noted hunters, he shot only when it was necessary for protection, or that specimens useful for scientific study might be brought back. The rest of the "shots" were made with a movie camera. Many times the back of an elephant, guided by two natives, furnished the stage for setting up the camera.

A CINEMATOGRAPHIC FORECAST FOR 1927

[Continued from Page 10]

made by the A.S.C. will be ready for announcement shortly after the first of the new year.

Cinematographers long since have come to the realization that nothing is stable within their profession. The greatest efforts of a given time become infinitesimal a short time later. But no artist of the camera objects to such a condition. In fact, such amounts to the life-blood of all his strivings. Within his heart he knows that he sets the pace for the upward trend of films at large. He is the limit beyond which the motion picture may or may not go artistically. If he marks time, there is no progress. That he has never marked time, the history of the art itself testifies.

Superinduced by the newly-discovered qualities of panchromatic, make-up for motion picture actors may likely undergo considerable revision. As already noted, no make-up whatsoever was used on "Old Ironsides." As a matter of fact, a great many cinematographers and directors frown upon the use of

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make-up wherever it can be avoided, on the ground that it covers up a true rendition of the facial expressions and of the emotions—and to correctly portray these, of course, is one of the prime designs of all film acting. A problem that is presented and which the researches of the American Society of Cinematographers are working out, occurs where the majority of the cast is appearing without make-up, and it becomes necessary to use cosmetics and the like to give character to certain of the heavier actors. A solution will be at hand for this, however, so that when the photoplay is projected no incongruities will be apparent.

Officers of the American Society of Cinematographers believe that there is no point of saturation in cinematography. It is a profession that can draw upon the untapped wells of not only literature and art, but upon chemistry and physics to an unfathomable degree. For this reason, researches of the A. S.C. will continue to be directed toward the end of discovering and encouraging new photographic methods and treatments. Exhaustive study of the American Society of Cinematographers convinces the writer that true universal usage of films has merely been approximated. This seems manifest when the on-rushing popularity of "home movies" is contemplated. Hundreds and hundreds of cameras and projectors using the 16 mm. film —about one-half the professional size—have already been sold, and as yet this outlet of the cinema has been merely scratched. In truth, many people hav not as yet segregated, in their minds, this new kind of home motion picture from the old magic lantern of a generation back. If it can be imagined that these new discoveries may place a small motion picture projector in as many homes as there are phonographs, radios or at least cameras, then the magnitude of this new form of entertainment may become evident. It is the writer's belief that 1927 will crystalize the usage of the 16 mm. film—with a resultant healthful condition for Hollywood, where films are made, because all of these small projectors must employ "moving pictures."

Amateur Cinematography

(Continued from Page 6)

to 16 mm. size. This reduced image, in turn, strikes the sensitized emulsion of the 16 mm. raw stock, which by means of perfect synchronization is drawn from a light-proof supply reel at the same speed as the standard negative. After the small size film is so exposed it is wound in a light-proof take-up magazine. The reduction process preserves all the detail of the original, standard size negative, and combined with the use of 16 mm. positive stock, with its slower emulsion speed and smaller grain, gives a perfect print.

Intensity Regulated

By regulating the intensity of the printing light, each scene is matched with the preceding and succeeding scenes. This regulation of the printing light is made by an automatic control board which is synchronized with the reducer, and which increases or decreases the light. The 16 mm. positive stock is available in several tints, so that the usual one color effects obtained on standard film may also be had on the small film. Light amber tinted stock improves the reductions and presents such a perfect picture on the screen that Mr. Horsley is using it for most all reduction films.

After the 16 mm. exposed film is taken from the optical reducer and unloaded in the darkroom, it is fed on the developing machine, going through the usual developing process and then wound on the drying drums. When the film has dried, it is then wound on a projection reel. Having been reduced and printed at the same time, it is naturally a positive, and is ready for projection in one of the "rush" rooms. During the inspection run every detail is carefully noted for correct development, detail, freeness from scratches, etc.

Editing

When the film is taken from the "rush" room, it is edited, eliminating, during this operation, any overexposed frames which occasionally appear. To facilitate this work, Mr. Horsley has converted a standard film viewing machine to 16 mm. size. This machine is of small size with a magnifying lens with a light behind it. By running the film through it, the individual frames are ob-

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served, and in consequence of the magnifying lens, the frames are enlarged for convenient viewing of the small image. In this operation the amateur cinematographer can appreciate the usefulness of this little mchine, for it saves the human eye a great deal of strain as is undoubtedly the case with normal viewing when editing one's films. It is to be hoped that some enterprising concern will make available a small size film viewing machine for the amateur cinematographer in the near future.

Splicing

The film has been viewed and marked for proper cutting and splicing. To facilitate splicing and assure neatness thereof, a standard Bell & Howell splicing machine has been converted for 16 mm. use, incorporating the lateral type of splice used with the amateur splicer made by the same company. This machine, too, is automatic, with the result that all splices are made with neatness and dispatch.

With the last operation completed in making the reduction films, they are then again put on projection reels and taken for showing in the completed picture projection room, after which they are packed in small cartons and are ready to be shipped.

B. & H. Distribution

Arrangements have been effected whereby the Bell & Howell Company will be the sole distributors of the reduction films which will be known as "The Filmo Library" subjects. Mr. Horsley predicts a wide-spread interest in these films, and pointed out to the writer that at the present time there are approximately twenty thousand amateur cinematographers using the Filmo projectors while there are an equally large number using the Kodascopes and Victor Cine-projectors.

The "Filmo Library" films are available in 100-foot, 16 mm., lengths, each a complete subject in itself. However, there are a few subjects which may be spliced together, making the usual 400-foot film of sixteen minutes projection time.

At the present time there are eight subjects already on the market. Among the first subjects there are: "Metro-Goldwyn-Mayer Studio and Stars," in two parts, containing views around this large studio and short excerpts of the M-G-M stars from their latest productions; a similar reel of the Christie Studios and stars; the world-famous Hollywood Bowl; and a number of subjects in the vaudeville series which include such acts as "Albert's Polar Bears," Spanuth's "Trained Baby Elephants," "Pickert's Seals," and the "Mikado's Royal Japanese Acrobats."

Additional subjects will be added to the library every month. Among those to be released for this month are: "Catching Big Fish in Pacific Waters"; "Whaling in the South Pacific"; "California Alligator Farm"; "Cawston Ostrich Farm"; "The Great Volcano Act"; "Fischer's Animal Circus"; "Cycling Girls", and further reels of the Hollywood movie studios of Universal and Warner Brothers.

(Continued from Page 19)

THE physical explanation of the phenomena of Refraction, through the Undulatory Theory of Light, is given by Huyghens as follows:

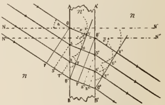

FIGURE 8. Huyghen's physical explanation of Refraction.

Let us suppose the source of light so distant, that the wave front is a spherical surface of such exceedingly great radius, that it may be considered a plane (traced by O P in the fig.) and the incident rays, parallel to each other.

Let the first medium be *air* and be designed by the letter ***n***, and the second medium let it be *glass* and be designated by the letter ***n'*** and let the refracted ray emerge again from the glass into the medium air.

At the very instant the extreme ray of the front-wave impinges upon the refracting surface at the point O, it becomes at that point, the origin of a new disturbance, originating secondary waves, which proceed within the

(Continued on Page 26)

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(Continued from Page 24)

medium *n'* at a velocity disminished, according to the density of the medium itself.

At the moment that the point P of the ray at the other extremiy of the beam of light, reaches the point O^1, the disturbance created by the ray first considered, will have reached the secondary wave-front, having a radius O V.

In the meantime, at all the intermediate points of the surface A B between O and O^1, and of which we shall take the points S and R as examples, similar disturbances as the one that has been created at O will have reached the wave-front having a radius S U, at the time at which P, reaches O^1. Similarly the disturbance created at R will have reached a wave-front having R T for radius.

Now, as according to Huyghens principle: "The resultant effects of the newly formed waves are produced only at the points of the surface which at any given instant touches all the secondary wave-fronts," the new wave front will be traced by the line O^1 V, which is tangent to all the secondary wave-fronts and as light always covers the shortest distance in its travelling, the rays within the medium glass, will herefore travel in the directions O O'; S S^1; R R^1, and O^1 O^2, making with the normals to the refracting surface at the points of incidence, *angles of refraction smaller than the angles of incidence*, as illustrated in the figure by the ray incident at O, which makes with the normal N N', an angle of incidence ***a*** and an angle of refraction ***a'***.

Let us, now, consider the rays travelling in *the medium n'*. The points O; S; R, and O^1, have become centers of disturbances and the Rays O O'; S S^1; R R^1, and O^1 O^2, travel within the glass with the same speed, as if they were actually originated at the incident points.

At the very instant that the Ray O O' reaches the surface A' B' at the point O', it becomes, at that point, the origin of another disturbance, originating secondary waves which proceed within the medium *n*, at an *increased velocity*, because the Medium *n* or AIR is less dense than the Medium *n'* GLASS, and at the time the Ray O^1 O^2 will have reached the point O^2, the new disturbances created at O', will have formed a secondary wave-front, having for radius the distance O' V^1.

Repeating the same reasoning and construction as above, we find the new wave-front to be traced by O^2 V^1 and the Rays emerging into *air*, to take a direction *parallel* to the Rays incident to the first surface of the glass. The ray O O', is found to make with the normal N^1 $N^{2\prime}$, an angle of incidence, a^1 *smaller* than the angle of refraction a^2.

From the figure, we can easily deduce that:

$$\frac{\text{Angle of Incidence}}{\text{Angle of Refraction}} \text{ equals } \frac{P\,O^1}{O\,V}$$

and as P O and O V are the distances covered *at the same time* by an incident and a refracted ray in the two different media respectively, we have

$$\frac{P\,O^1}{O\,V} \text{ equals } \frac{\text{Velocity of Light in Medium } n}{\text{Velocity of Light in Medium } n'}$$

and representing the Velocity of Light in Medium *n* by the sign V*n* and its Velocity in Medium *n'*, by the sign V*n'* and using the sine values for the angles of incidence and refraction, we have

$$\frac{\sin a}{\sin a'} \text{ equals } \frac{Vn}{Vn'}$$

which is a *constant* for any pair of media, and is called the "*refracting* index" of the medium *n'*.

Calling *n* the refracting index of the first medium and *n'* the refracting index of the second medium, we have $\sin a . n$ equals $\sin a . n'$

$$\text{equals } \frac{\sin a}{\sin a'} \text{ equals } \frac{n'}{n} \text{ which constant is}$$

called the "*relative refractive index*" of the two Media in question.

If the first Medium is *vacuo*, *n* is taken as *unity* and we have

$$\frac{\sin a}{\sin a'} \text{ equals } \frac{n'}{n} \text{ equals } \frac{n'}{1} \text{ equals } n' \text{ which}$$

is termed the "*absolute refractive index*" of a Medium. It is evident that the Absolute Refractive Index of all transparent bodies, from the rarest of gases to the densest of solids, is always greater than one.

THE discovery of the laws of Reflection and Refraction can be classed among the greatest of the achievements of human intellect. The conception and construction of all optical instruments, from the simple spectacle lens to the most intricate apparatus, used in scientific and industrial enterprises, have been made possible by the knowledge of these laws, and mankind derives from them incalculable profits of knowledge, security and comfort.

(To be continued next month.)

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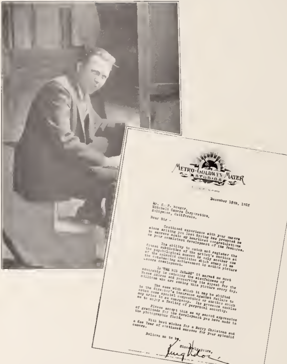

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